Choice of Hospital for Delivery: A Comparison of High-Risk and Low-Risk Women

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Objective. This article tests whether or not the factors that affect hospital choice differ for selected subgroups of the population.

Data Sources. 1985 California Office of Statewide Health Planning and Development (OSHPD) discharge abstracts and hospital financial data were used.

Study Design. Models for hospital choice were estimated using McFadden's conditional logit model. Separate models were estimated for high-risk and low-risk patients, and for high-risk and low-risk women covered either by private insurance or by California Medicaid. The model included independent variables to control for quality, price, ownership, and distance to the hospital.

Data Extraction. Data covered all maternal deliveries in the San Francisco Bay Area in 1985 ($N = 61{,}436$). ICD-9 codes were used to classify patients as high-risk or low-risk. The expected payment code on the discharge abstract was used to identify insurance status.

Principal Findings. The results strongly reject the hypothesis that high-risk and low-risk women have the same choice process. Hospital quality tended to be more important for high-risk than low-risk women. These results also reject the hypothesis that factors influencing choice of hospital are the same for women covered by private insurance as for those covered by Medicaid. Further, high-risk women covered by Medicaid were less likely than high-risk women covered by private insurance to deliver in hospitals with newborn intensive care units.

Conclusions. The results show that the choice factors vary across several broadly defined subgroups of patients with a specific condition. Thus, estimates aggregating all patients may be misleading. Specifically, such estimates will understate actual patient response to quality of care indicators, since patient sensitivity to quality of care varies with the patients' risk status.

Keywords. Hospital choice, quality of care, maternity care, conditional choice models, socioeconomic factors

In choosing a hospital to enter for treatment, a number of factors may enter an individual's thinking. For instance, which hospital, from among the possibilities, has the most up-to-date facilities? Where does my physician suggest I go? Do I anticipate the need for special intensive services? Where will I feel most comfortable? Where do many of the people I know go? Will my insurance coverage allow me to choose this hospital? How far away is the hospital? For each person, each of these factors varies in relative importance. Some people may prefer proximity while others may value backup intensive care services.

Several investigators have used linear versions of conditional-choice models to look at the factors influencing hospital admissions for all patients (Folland 1983; Lee and Cohen 1985; Erickson and Finkler 1985) or for aggregated subgroups (McGuirk and Porell 1984). In all of these models, distance from the patient's home to the hospital was the most important factor. Garnick, Lichtenberg, Phibbs, et al. (1989) have

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shown that it is preferable to use maximum-likelihood estimators instead of linear approximations. Luft, Garnick, Mark, et al. (1990) used this method to examine hospital choice for 12 diagnoses and surgical procedures. They found differences in the relative influence of the factors affecting hospital choice across different diagnoses and procedures. This finding raises an obvious question: do the factors that influence hospital choice vary across subgroups of patients with the same diagnosis?

We used maternal delivery to test for differences in hospital choice across subgroups of patients with the same medical condition. Delivery is a good choice for examining these differences because of the long time that passes between first knowledge of the need for hospital services and the date when provision is actually required. Expectant mothers have more time to shop around for the hospital that best meets their needs than do patients with most other conditions. The concerted efforts to regionalize perinatal care for high-risk women and infants (McCormick, Shapiro, and Starfield 1985) should also influence the observed hospital choices. Finally, the large number of deliveries yields a sufficient volume of perinatal deaths (despite relatively low mortality rates) to make it feasible to use perinatal mortality as a marker for hospital quality.

The primary purpose of this study was to examine factors that may influence different subgroups of the general population in their choice of a hospital for delivery. We specifically focused on the choices of mothers considered to be at high risk of facing serious complications for themselves or their infants and of mothers considered to be at low risk. In this article we used data from all hospitals in the greater San Francisco Bay Area with delivery services in 1985. Hospital choice was modeled as a function of four types of variables: quality, price and payment, hospital ownership, and geographic access. This model is estimated separately for the high-risk and low-risk groups to compare differences in hospital choice by risk status. For each of these risk groups, we also looked at the effects of payment source on choice by comparing the hospital choice of women covered by California Medicaid (Medi-Cal) with that of women covered by private insurance.

DATA

Hospital discharge abstracts for 1985 from the Office of Statewide Health Planning and Development (OSHPD) were selected for all patients for whom delivery was the listed type of admission. To reduce the data set to a manageable size, deliveries only from zip codes in the greater San Francisco Bay Area were considered.[1] The size of this area (over 100 miles long and about 30 miles wide) and its number of hospitals were sufficient to mean that fewer than 1.5 percent of all patients residing in the region received hospital care outside of its boundaries. Patients hospitalized in federal, state, or HMO hospitals were excluded since their choice of hospital was more limited than that of other patients. The hospital discharge data included the zip code of patient residence, which we used to determine the geographical origin of the patient. The discharge abstracts also contained data on maternal diagnoses, procedures, age, race, hospital charge,[2] and expected source of payment.

Data on hospital ownership, teaching status, and facilities were obtained from the OSHPD Hospital Disclosure Report. Data on the level of newborn intensive care available at each hospital were obtained from the Maternal and Child Health Section of the California Department of Health Services. Data on the Medi-Cal contract status were obtained from a published report of the California Department of Health Services (1988). Latitude and longitude coordinates for residential zip codes were obtained from commercially available geographic files. Exact coordinates for hospitals were determined from topographic maps plotted by the U.S. Geological Survey. Data on risk-adjusted birth outcomes were obtained from the California Maternal and Child Health Data Base (Rust, Rust, and Williams 1989).

METHODS

STATISTICAL MODEL

Qualitative-choice models are a class of methods used to study situations in which an individual chooses from among a set of alternatives. These models may be estimated using the conditional logit method developed by McFadden (1974). The attractiveness of hospital j to patient m in location i, Y^*_{ijm}, is a linear function of observable attributes of the hospital and patient, X_{ijm}, and random variables, e_{ijm}:

$$Y^*_{ijm} = V(X_{ijm}) + e_{ijm}$$

The probability that hospital j is chosen equals the probability that it is more attractive than all other hospitals in the choice set. If the random components, e_{ijm}, have identical independent Weibull distributions, then the probability of observing the selection of hospital j by patient m in location i, p_{ijm}, is:

$$p_{ijm} = \{\exp[V(X_{ijm})]\} \;/\; \{\Sigma_k \exp[V(X_{ijm})]\} \quad k = 1, \ldots, N$$

where N is the number of hospitals. The advantage of this model is that in generating the parameter estimates it explicitly considers the characteristics of the alternatives that were rejected as well as the one that was chosen. We have shown elsewhere that the maximum-likelihood method of estimating the parameters for this particular type of problem is more robust than the other commonly used methods (Garnick, Lichtenberg, Phibbs, et al. 1989).

A key assumption of the conditional logit model is the independence of irrelevant alternatives (IIA). This assumption implies that the addition or subtraction of alternative choices will not affect the estimated parameters. We tested for violation of this assumption using the auxiliary regression method of McFadden (1987).[3] This test is asymptotically equivalent to the test of Hausman and McFadden (1984). This test did not reject the IIA assumption (χ^2 = 0.6, d.f. = 17).[4]

Given that we specifically designate different levels of hospitals, based on the level of care provided, we also considered the possibility that a nested logit model should be used. For this application, a nested logit model would have the first level of analysis examine choice across groupings of comparable hospitals and the second level of analysis examine choice within each grouping. This was of specific concern for this analysis, since high-risk women might consider only hospitals that offered tertiary services. Again, the auxiliary regression to test failed to reject the assumption that the model was not nested (χ^2 = 0.4, d.f. = 16) (McFadden 1987).

PATIENT SUBGROUPS

Deliveries were classified as high- or low-risk based on the American Academy of Pediatrics/American College of Obstetrics and Gynecology Guidelines for Perinatal Care (1988). These guidelines define the level of care appropriate for different maternal conditions.[5] We classified as high-risk deliveries the 23,903 women who had at least one of the guideline conditions for which it is recommended that delivery occur in a hospital with at least an intermediate-level neonatal intensive care unit (NICU). All deliveries not identified as high-risk were classified as low-risk. Our coding scheme was designed to ensure that we captured all high-risk women. With 38.9 percent of the cases classified as high-risk, we almost certainly classified many women who were actually of moderate or nominal risk as high-risk: this admittedly dilutes the observed effects of risk status on choice of hospital.

Many of the conditions that classify a pregnancy as high-risk, such as maternal chronic disease, can be identified in advance. Others, such as severe hypertensive disorders, surface later in pregnancy, but even then patients and physicians can consider switching hospitals. Conditions, such as preterm labor, that cannot always be predicted are those that the mother or her physician should immediately regard as unstable/precarious. The standard of care in these cases is to transfer or directly refer the high-risk mothers to a site that offers the appropriate level of care if the mother is stable enough to allow the move. Thus, it seems plausible that joint patient-physician preferences about where to deliver will be different for women identified as being high-risk, than for low-risk women—up to the point where transfer of the mother is considered unsafe. Specifically, high-risk women and their physicians who know their risk status, should be more willing than low-risk women and their physicians to travel farther, and should be more concerned about quality and the services available to treat high-risk cases. To test for differences in the choice process between high- and low-risk patients, the model was estimated separately for each group (unrestricted models). These estimates were compared with the estimates of data pooled from both groups, which had forced the parameter estimates to be equal for both groups (restricted model). The difference between the log likelihood of the restricted model and the sum of the log likelihoods of the unrestricted estimates is distributed χ^2 with k degrees of freedom, where k is the number of regressors in the model.

The demographic and socioeconomic characteristics of Medi-Cal–eligible women are quite different from those of the insured population. With respect to choice of hospital, their increased reliance on public transportation is especially important. In addition, the willingness of physicians and hospitals to accept Medi-Cal patients may differ from their willingness to treat insured patients. Therefore, the parameters of the choice model are likely to be different for these two patient groups. For this test, patients with an expected payment source of Medi-Cal were compared with patients whose expected source of payment was some form of private insurance (commercial insurance, Blue Cross, Blue Shield, non-Kaiser HMO or other prepaid plan, or Medicare).[6] Patients not included in these two groups were excluded from the comparison. To focus the comparison on the differences between these two groups, this comparison was made separately for the high-risk patients and the low-risk patients. The unrestricted models were separate estimates for the Medi-Cal patients versus insured patients, and the restricted model was for all patients in these two groups.

VARIABLES IN MODEL

The dependent variable for our estimates was patient-hospital pairs. Since the data elements are identical for all patients in a zip code who chose the same hospital, we aggregated to the zip code–hospital level and weighted the estimates by the number of patients in each pair for computational convenience. Thus, computationally, the dependent variable was the number of patients from a given zip code who chose a given hospital. The independent variables in the model included zip code–specific patient characteristics and characteristics of each hospital. These variables could be categorized into four general groups: quality, charges, ownership, and distance. Table 1, further on, shows the mean values of the variables used in the analysis: by hospital, for all patients, for the high-risk and low-risk patients, and for the low-risk and high-risk private-pay and Medi-Cal patients.

QUALITY

We used both structural and outcome variables to measure the quality of care. The level of neonatal intensive care available is a measure of the range of services the hospital is able to provide to infants. These units should tend to attract more women who anticipate a high-risk delivery. Given that some complications cannot be predicted in advance, giving birth at a hospital with a NICU assures the availability of any level of care that may be required. Therefore, the presence of a NICU may be a feature that attracts some women for low-risk deliveries. We used data from the California Department of Health Services to create categorical variables for the presence of level III (tertiary), high-level II (intermediate), and low-level II NICUs. Teaching affiliation with a medical school may also be interpreted as a marker of quality by some women. Other low-risk women may wish to avoid the "extra attention" commonly associated with the clinical training of house staff and medical students in teaching hospitals.

Hospital characteristics that can affect the birth experience may influence the mother's choice. We included binary variables for the presence of an alternative birth center and the provision of parent training classes. By 1985, the rapid increase of cesarean section deliveries was well documented, and many experts were questioning whether or not all of them were necessary (Bottoms, Rosen, and Sokol 1980; Fraser, Usher, McLean, et al. 1987; Gleicher 1984). On the other hand, it has been shown that cesarean section delivery may improve outcomes, especially for high-risk infants (Williams and Hawes 1979). We included the hospitals' cesarean section rates in the model to control for the fact that this variable might affect choice of hospital.[7] Cesarean sections were identified by a primary or secondary ICD-9 procedure code of 740–744 or 749. Percentages of cesarean sections were based on all delivery patients in each hospital, including those who lived outside the San Francisco Bay Area.

Although an expectant mother is obviously concerned about her own well-being, the rarity of maternal mortality makes it likely that newborn outcomes are predominant in her assessment of hospital quality. For newborns, the dominant risk factor is birth weight. Since exact birth weight data are not available on the OSHPD discharge data, we used a *Z*-score–based outcome measure derived from vital records data as a hospital-level measure of quality (Williams 1979; Rust, Rust, and Williams 1989). This measure adjusts for birth weight, sex, race, and plurality to calculate an expected perinatal mortality rate for each hospital. Indirect standardization was used to compare the expected mortality rate with the actual mortality rate. The *Z*-score was used to correct for differences in sample size across hospitals, which affects the level of confidence associated with observed outcomes. A *Z*-score of zero implies that the actual number of perinatal deaths equaled the expected number of deaths. *Z*-scores greater than zero imply that actual deaths were greater than expected deaths, with the converse true for *Z*-scores less than zero. This measure has been shown to be a good indicator of the quality of perinatal care independent of socioeconomic status (Williams 1979). Since the *Z*-score takes the birth weight as it is given, and adjusts for this risk accordingly, the potential for omitted-variable bias due to the correlation between lower birth weights and socioeconomic status is reduced. It has been shown that selective maternal referral of cases with congenital anomalies introduces a bias in the *Z*-scores of some tertiary hospitals in California (Rust, Rust, and Williams 1989). To eliminate this bias, we used the *Z*-scores that Rust et al. calculated after deleting all deaths due to congenital anomalies.[8]

CHARGES

Although insurance coverage reduces the effective price for hospital services, relative price has still been found to influence hospital choice for some conditions (Luft, Garnick, Mark, et al. 1990). To capture this effect we used the hospital charge listed on the discharge abstract in the model. To adjust for the effect of case mix on charges, we estimated a regression model where charges were dependent on mother's age, expected payment source, race, cesarean section, emergency room admission, whether the hospital included physician charges in its bill, and whether the hospital had a Medi-Cal contract. This model was estimated for low-risk deliveries only, to minimize the possibility that unobserved case-mix difference might bias the results.[9] We used the ratio of actual charges divided by expected charges to control for the effect of relative-price differences in the conditional choice model.

MEDI-CAL CONTRACTING

In 1982, California passed legislation switching Medi-Cal to a selective contracting program and enabling formation of preferred provider organizations (PPOs).[10] Both of these changes restricted the options of many patients. To control for the hospital's eligibility for Medi-Cal births (about 20 percent of all births), our model included the number of months in which each hospital had a Medi-Cal contract. Unfortunately, data on PPOs are not readily available; thus, their effect could not be examined.

SOCIOECONOMIC STATUS

The socioeconomic status of patients may influence their choice of hospital. Indigent patients may be concentrated at public institutions and a limited number of other hospitals due to the restrictions of Medi-Cal selective contracting, patient reliance on public transportation, and the unwillingness of some hospitals to accept uninsured or underinsured patients. More affluent patients may prefer well-appointed hospitals that cater to their needs. To test the magnitude of such socioeconomic grouping, we created a variable that combined the percent of each hospital's patients who had private insurance with the percent of the population in each zip code with at least some college education.[11] However, simply multiplying these variables would not have picked up the desired effect, since high education–high percent insured combinations would be near one while low education–low percent insured combinations would be near zero. Under a "likes attract" hypothesis, these two combinations need to be similar. Thus, the interaction term we included is based on the deviations from the mean value of each of the components.

This variable yields large positive values for the high-high and low-low groups. It yields large negative numbers for opposites (low-education zip code paired with a high percent–insured hospital and high education zip code paired with a low percent–insured hospital). A positive coefficient can be interpreted as support for the hypothesis that individuals of high (low) socioeconomic status (SES) tend to concentrate their admissions in hospitals that primarily serve individuals with good (poor) insurance coverage. The subsamples used in the comparison of

Medi-Cal and privately insured patients limit the variance of the SES interaction variable just described; Medi-Cal patients tend to come from lower-education zip codes, and private-paying patients tend to come from higher-education zip codes. Thus, any variance that remains is due mostly to differences in the percentage of each hospital's admissions covered by private insurance. To avoid the reduction in the variance induced by the interaction term, we used the percentage of each hospital's patients covered by private insurance for the models comparing Medi-Cal and privately insured women. Here, the "likes attract" hypothesis would imply a positive coefficient for the private insurance subsample and a negative coefficient for the Medi-Cal subsample.

OWNERSHIP

Ownership status may also influence choice of hospital. The strongest factor is probably local government ownership, since these hospitals, which primarily serve indigent populations, often are less attractive to privately insured patients for this reason. Hospitals operated by local hospital districts, while controlled by a publicly elected board, do not have a special mission to serve the poor. It is unclear how this type of ownership influences choice of hospital. Many individuals wish to avoid for-profit hospitals in the belief that profit making is inconsistent with high-quality care. Depending on one's beliefs, Catholic ownership may be regarded as an attraction or, possibly, detraction. We created binary variables for each of these ownership categories. The excluded category is private, not-for-profit, non-Catholic hospitals.

DISTANCE

Hospital markets are relatively localized (Garnick et al. 1987). Thus, patients tend to prefer hospitals closer to home. Because neither road distance nor travel times were available, straight-line distance was calculated from the location of the patients' zip code to the exact location of each hospital using latitude and longitude coordinates. To account for the bottlenecks associated with travel in the San Francisco Bay Area, we included a variable indicating whether a bridge or tunnel would be used on the most direct route between a zip code and a hospital.

RESULTS

The final data set included 61,436 deliveries. Of these, 37,583 (61.1 percent) were classified as low-risk, and 23,903 (38.9 percent) were classified as high-risk. Of the low-risk deliveries, 9,329 (24.9 percent) were covered by Medi-Cal and 23,500 (62.6 percent) were covered by private insurance. Medi-Cal covered 6,725 (28.1 percent) of the high-risk deliveries, and private insurance covered 14,987 (62.7 percent) of them. The remaining deliveries were self-pay or HMO, and were not included in the payer source comparisons. Table 1 shows the means of the variables in the model for all deliveries and for each subgroup. Among the data subsets shown on Table 1, most of the variables are similar for all of the groups. There are, however, some notable exceptions. Compared to low-risk patients, many more high-risk patients use teaching hospitals and hospitals that provide level III newborn intensive care. High-risk patients are also concentrated in hospitals with lower risk-adjusted mortality rates. Many fewer Medi-Cal patients cross a transportation bottleneck (bridge or tunnel) than private-pay patients. A much higher percentage of Medi-Cal patients use public and Catholic hospitals. Surprisingly, there was no difference in the cesarean section rate between high-risk and low-risk women.

Table 1 also shows the means for the 48 San Francisco area hospitals. About half of the hospitals are private, not-for-profit hospitals. Most of the hospitals provide parent training classes and have an alternative birth center. Slightly over one-third of the hospitals provide some level of newborn intensive care. Medi-Cal contracts were present at 27 of the hospitals for all 12 months of 1985, and one had a contract for seven months. The remaining 20 hospitals had no Medi-Cal contract at any time in 1985.

Table 2 shows the results for the estimates for all deliveries and the high- and low-risk subsets. Quality, price, ownership, and distance all had significant effects on the choice of hospital, as we have previously found for other types of cases (Luft et al. 1990). Teaching hospitals and hospitals that provide newborn intensive care were preferred, with higher levels of newborn intensive care preferred over lower levels. Better outcomes, as measured by the risk-adjusted *Z*-score for perinatal mortality, also increased the probability that a mother would choose to deliver at a particular hospital. Patients also preferred hospitals that offered parent training classes and alternative birth centers, and hospitals that had higher cesarean section rates. Holding other factors constant, patients preferred hospitals with lower charges. Having a contract with the state Medi-Cal program reduced the probability that a hospital would be chosen. The SES interaction variable had the expected positive effect. Catholic hospitals were more attractive, as were public hospitals, than proprietary and district hospitals. Straight-line distance from the zip code of patient residence to the hospital had a very strong effect on

Table 1: Mean Values for Variables in Regression Models

		All			*Low-Risk*		*High-Risk*	
	Hospitals	*Deliveries*	*Low-Risk*	*High-Risk*	*Private-Pay*	*Medi-Cal*	*Private-Pay*	*Medi-Cal*
N	48	61,436	37,533	23,903	23,500	9,329	14,987	6,725
Z-score of risk-adjusted perinatal death rate	0.02	-0.47	-0.32	-0.70	-0.43	-0.37	-0.72	-0.95
Teaching hospital	16.7%	24.5%	21.0%	30.0%	16.9%	21.1%	23.7%	32.1%
Newborn intensive care unit	12.5%	25.3%	20.4%	33.0%	19.2%	20.6%	29.7%	37.3%
High intermediate newborn intensive care unit	10.4%	18.5%	19.8%	16.4%	20.6%	17.3%	16.6%	14.3%
Low intermediate newborn intensive care unit	14.6%	21.2%	22.0%	20.1%	26.2%	13.0%	23.6%	15.4%
Cesarean section rate	24.5%	23.9%	23.9%	23.9%	25.1%	22.5%	25.1%	22.6%
Parent training classes	70.8%	77.3%	77.3%	77.2%	78.7%	82.8%	80.5%	79.0%
Alternative birth center	81.3%	85.2%	85.6%	84.6%	90.4%	76.1%	91.4%	72.5%
Ratio of actual to expected charges	0.978	1.001	1.004	0.997	0.997	1.015	0.989	1.013
Number of months hospital had Medi-Cal contract 1985	6.9	7.8	7.4	8.3	6.4	9.7	7.1	10.5
SES interaction variable*		0.285	0.286	0.285	0.343	0.175	0.352	0.176
Public	10.4%	16.4%	16.1%	16.8%	6.9%	30.3%	5.7%	30.3%
Proprietary	2.1%	0.3%	0.5%	0.1%	0.6%	0.2%	0.1%	0.2%
District	22.9%	14.1%	14.8%	13.1%	16.7%	11.4%	16.2%	7.5%
Catholic	14.6%	13.5%	14.1%	12.6%	12.6%	20.7%	11.2%	18.4%
Distance (log miles)		1.320	1.297	1.358	1.396	1.069	1.455	1.171
Bridge or tunnel†		0.049	0.044	0.056	0.055	0.018	0.070	0.027

*Percent of hospital's patients who had private insurance multiplied by the percent of the zip code population that had at least some college education; for the high-risk and low-risk private pay and Medi-Cal patients (columns 5–8), this variable is percent of hospital's patients with private insurance.

†Binary variable indicating whether a bridge or tunnel would be used in the most direct route between a zip code and a hospital.

Table 2: Regressions Comparing Hospital Choice for High- and Low-Risk Deliveries

	All Deliveries		*Low-Risk*		*High-Risk*	
	Coefficient	t-*Ratio*	*Coefficient*	t-*Ratio*	*Coefficient*	t-*Ratio*
Z-score of risk-adjusted perinatal death rate	-0.0458	-9.50	-0.0373	-6.03	-0.0750	-9.53
Teaching hospital	0.1017	4.52	0.0450	1.54	0.2320	6.49
Newborn intensive care unit	1.5783	56.21	1.2700	35.11	1.9409	42.66
High intermediate newborn intensive care unit	1.3483	72.29	1.3494	58.28	1.3143	41.28
Low intermediate newborn intensive care unit	0.7603	49.95	0.7575	39.94	0.7785	30.18
Cesarean section rate	1.1761	7.91	0.6741	3.63	2.2215	8.94
Parent training classes	0.4818	33.72	0.4214	23.12	0.5584	23.84
Alternative birth center	0.4929	30.05	0.4738	22.95	0.5685	20.69
Ratio of actual to expected charges	-0.4702	-11.87	0.1135	2.21	-1.3562	-21.27
Number of months hospital had Medi-Cal contract 1985	-0.0237	-19.21	-0.0218	-14.12	-0.0271	-13.03
SES interaction variable*	5.9146	41.18	5.5808	29.94	6.4274	28.23
Public	0.1531	7.20	0.0598	2.19	0.3486	10.04
Proprietary	-0.5051	-4.88	-0.2061	-1.78	-1.5283	10.04
District	-0.2093	-12.15	-0.2624	-12.13	-0.1023	-3.56
Catholic	0.3011	13.97	0.2777	10.34	0.3587	9.81
Distance (log miles)	-1.3727	-295.01	-1.3772	-231.59	-1.3692	-181.53
Bridge or tunnel†	-1.8238	-87.17	-1.9480	-69.87	-1.6316	-51.38
Pseudo R^2	0.48		0.49		0.48	

*Percent of hospital's patients who had private insurance multiplied by the percent of the zip code population that had at least some college education.

†Binary variable indicating whether a bridge or tunnel would be used in the most direct route between a zip code and a hospital.

the choice of hospital. The necessity of passing through a major traffic bottleneck (a bridge or tunnel) to reach a hospital also reduced the probability that that hospital would be chosen.

The hypothesis that the high- and low-risk patients made the same hospital choices for delivery was rejected ($p < .001$ $\chi^2 = 800$, d.f. = 17). The third and fifth columns of Table 2 show the estimates of the separate models for the high- and low-risk groups. Low- and high-risk women placed about the same importance on the presence of intermediate newborn intensive care, a hospital's Medi-Cal contract status, and distance. High-risk women had stronger preferences for hospitals with better quality measures (lower risk-adjusted mortality rates, teaching hospitals, and hospitals with level III NICUs), and were more willing to travel through a traffic bottleneck to reach their preferred hospital. Women expecting high-risk deliveries were more willing to go to a public hospital, more likely to deliver at hospitals with high cesarean section rates, and more likely to avoid a proprietary hospital than were women expecting low-risk deliveries. Surprisingly, women in the high-risk category seemed more sensitive to charges than those in the low-risk group.

Table 3 shows the estimates that compare the low-risk Medi-Cal and private insurance subgroups. The hypothesis that low-risk patients covered by Medi-Cal and patients covered by private insurance made the same choices was rejected ($p < .001$ $\chi^2 = 4{,}963$, d.f. = 17). Medi-Cal patients were less likely than women with private insurance to choose a teaching hospital, a hospital with a NICU (any level), a hospital with a high cesarean section rate, a hospital with a higher risk-adjusted mortality rate, a hospital with an alternative birth center, a proprietary hospital, or a hospital that was more difficult to reach. They were more likely to choose a hospital with a Medi-Cal contract, a hospital with higher charges, a hospital that offers parent training classes, or a public hospital. The percentage of a hospital's admissions covered by private insurance has a significant positive effect for the private-pay patients and a significant negative effect for the Medi-Cal patients.

The estimates that compare the high-risk Medi-Cal and private insurance patients are shown in Table 4. The hypothesis that these high-risk subgroups have the same choice model was rejected ($p < .001$ $\chi^2 = 3{,}407$, d.f. = 17). In general, although the magnitude of the differences varied, the direction of the differences between the two subgroups was the same as that of the differences between the low-risk subgroups. The exceptions were (1) the increased aversion of privately insured high-risk patients to proprietary hospitals—now equal to that of Medi-Cal patients; (2) the stronger aversion of patients with private insurance to hospitals with high *Z*-scores, instead of a weaker aversion; and (3) the

Table 3: Comparison of Hospital Choice by Low-Risk Mothers with Private Insurance and Medi-Cal Coverage

	All Low-Risk		*Private*		*Medi-Cal*	
	Coefficient	t-*Ratio*	*Coefficient*	t-*Ratio*	*Coefficient*	t-*Ratio*
Z-score of risk-adjusted perinatal death rate	-0.0847	-11.88	-0.0492	-5.16	-0.1454	-10.73
Teaching hospital	-0.1493	-4.54	-0.1439	-3.21	-0.3936	-6.70
Newborn intensive care unit	1.1048	26.75	1.6526	27.88	0.6498	9.36
High intermediate newborn intensive care unit	1.2697	51.85	1.6468	54.75	0.7940	14.39
Low intermediate newborn intensive care unit	0.5994	30.19	0.8647	36.07	-0.2832	-5.15
Cesarean section rate	-1.0689	-5.10	-0.0914	-0.35	-0.1445	-0.33
Parent training classes	0.5705	28.78	0.5808	24.78	0.9379	19.69
Alternative birth center	0.1732	7.43	0.2347	7.45	-0.2571	-5.97
Ratio of actual to expected charges	0.1086	1.95	0.1111	1.68	0.6602	5.20
Number of months hospital had Medi-Cal contract 1985	0.0176	9.77	0.0012	0.58	0.0810	16.12
Percent of hospital's patients with insurance	1.7892	35.74	3.0111	46.89	-1.4800	-14.16
Public	0.6217	18.28	-0.0938	-1.92	0.7222	11.01
Proprietary	-0.4988	-3.97	-0.1826	-1.26	-1.5363	-5.35
District	-0.3979	-17.44	-0.3852	-14.36	-0.5521	-10.21
Catholic	0.3351	11.95	0.5593	14.98	0.3629	6.83
Distance (log miles)	-1.4156	-220.77	-1.4690	-187.25	-1.3821	-107.76
Bridge or tunnel*	-1.9318	-65.06	-1.6780	-51.40	-3.0282	-36.05
Pseudo R^2	0.50		0.52		0.59	

*Binary variable indicating whether a bridge or tunnel would be used in the most direct route between a zip code and a hospital.

Table 4: Comparison of Hospital Choice by High-Risk Mothers with Private Insurance and Medi-Cal Coverage

	All High-Risk		*Private*		*Medi-Cal*	
	Coefficient	t-*Ratio*	*Coefficient*	t-*Ratio*	*Coefficient*	t-*Ratio*
Z-score of risk-adjusted perinatal death rate	-0.1190	-13.15	-0.4449	-3.49	-0.2221	-12.42
Teaching hospital	0.1118	2.78	-0.0688	-1.18	0.1916	2.76
Newborn intensive care unit	1.7591	34.58	2.5913	33.47	1.1410	13.00
High intermediate newborn intensive care unit	1.2280	36.72	1.5329	37.21	0.8412	11.28
Low intermediate newborn intensive care unit	0.5783	21.75	0.6852	21.52	0.1425	2.00
Cesarean section rate	0.1890	0.69	1.3857	4.02	-0.7913	-1.36
Parent training classes	0.7086	28.24	0.6987	23.25	1.1652	19.11
Alternative birth center	0.1528	5.02	0.1160	2.73	-0.0299	-0.53
Ratio of actual to expected charges	-1.5299	-22.18	-1.7587	-20.68	-0.5660	-3.81
Number of months hospital had Medi-Cal contract 1985	0.0163	6.74	-0.0007	-0.25	0.1021	14.72
Percent of hospital's patients with insurance	1.9889	30.11	3.6035	40.45	-1.3384	-10.66
Public	0.9785	22.15	0.3970	6.18	0.8124	9.53
Proprietary	-1.8453	-7.72	-1.8252	-5.88	-1.7517	-4.50
District	-0.2951	-9.73	-0.1822	-5.17	-0.7486	-9.79
Catholic	0.3986	10.57	0.7786	15.22	0.1967	2.77
Distance (log miles)	-1.4043	-173.33	-1.4469	-144.87	-1.3970	-87.34
Bridge or tunnel*	-1.6197	-48.16	-1.3429	-35.73	-2.6839	-30.70
Pseudo R^2	0.49		0.51		0.59	

*Binary variable indicating whether a bridge or tunnel would be used in the most direct route between a zip code and a hospital.

finding that Medi-Cal patients are now more likely, instead of less likely, to select a teaching hospital.

DISCUSSION

The results presented here clearly show that the relative influence of various factors affecting patients' choice of hospitals differs for various subgroups of patients with one clinical condition in common: maternal delivery. For almost all of the variables in the model, the effects took the same direction but differed in magnitude. We chose to look at maternal delivery since it was relatively simple to identify the high-risk patients, and the volume of cases made it more likely that we would find statistically significant differences. Further, the relatively long period of advanced notice of the need for hospitalization before delivery increases the ability of the patient to shop around. Additional studies must be done to determine whether differences in choices among subgroups of patients will also be observed for other diagnoses and procedures where patients have less advance notice of the need to be hospitalized.

We have previously shown that differences exist in hospital choices among patients with different conditions (Luft, Garnick, Mark, et al. 1990). The results presented here indicate that the estimates of patients' choice of hospital vary across identifiable subgroups within a defined group of patients. Researchers will need to be sensitive to these potential differences in applying these models. Specifically, when interested in particular subgroups of patients, researchers will have to estimate the models separately for those subgroups. Given that the number of patients in any one zip code who choose a particular hospital for treatment declines rapidly as the subgroup under study is narrowed, such analysis will increase the number of zip code–hospital pairs with zero patients. This implies that such estimates will have to use maximum-likelihood estimates, instead of linear-approximation techniques, to obtain stable parameter estimates (Garnick, Lichtenberg, Phibbs, et al. 1989).

The comparison between the high- and low-risk cases shows that those factors likely to have a strong effect on expected outcome were more influential in the choice of hospital by high-risk women (and/or their physicians). This is consistent with the hypothesis that the sensitivity of demand to quality varies directly with the probability of perinatal death: the greater the risk of perinatal mortality, the more the patient is concerned about the expected quality of care. If this finding holds for other diagnoses, then estimates that aggregate all patients with a given diagnosis will not accurately measure the quality elasticity of demand unless they include some measure of case mix (i.e., the risk of mortality of each patient).

Most of the results presented here were consistent with expectations. The increased willingness of high-risk women to give birth in hospitals with higher cesarean section rates is consistent, given that for high-risk cases cesarean deliveries have been shown to be associated with improved outcomes (Williams and Hawes 1979). Although low-risk women do not ignore quality, they tend to place less importance on the outcome-oriented quality factors we included, which is consistent with their low-risk status. These mothers seem to place more emphasis on factors perceived to influence the "ambiance" of the birth experience. Specifically, they are less likely to choose a tertiary teaching hospital, and thus can avoid the extra "attention" of house officers and medical students.

Caution must be applied in interpreting some of the differences in the estimated parameters between women covered by Medi-Cal and those covered by private insurance. Although the coefficients for the privately insured patients almost certainly reflect the preferences of those patients and their physicians, we cannot draw the same conclusions for women covered by Medi-Cal. The "choice" estimates for the Medi-Cal sample were also influenced by access restrictions and factors associated with serving large Medi-Cal populations. This may provide a partial explanation for the results that show Medi-Cal patients with a stronger preference for higher-charge hospitals.[12] Similarly, what appears to be a stronger aversion to cesarean sections by Medi-Cal mothers may be due not to patient preference but to the fact that resource-constrained public hospitals simply perform fewer cesarean sections.[13]

A more disturbing finding is that high-risk women covered by Medi-Cal were more likely to choose hospitals with worse perinatal outcomes (higher Z-scores), and were less likely to deliver at hospitals providing any level of specialized care for newborns. These results raise the possibility that high-risk women covered by Medi-Cal face barriers to care at appropriate facilities. We cannot identify the cause of these differences with our model, but this matter merits further investigation.

Most of the observed differences between the Medi-Cal and privately insured groups have more standard explanations. For example, Medi-Cal patients were more likely to be admitted to a public hospital or to a hospital with a Medi-Cal contract, and were less likely to be admitted to a proprietary hospital. As our "likes attract" hypothesis predicts, they were more likely to be admitted to a hospital with a larger proportion of uninsured patients. Although the distance parameters were about the same, the much larger estimate for the bridge-tunnel variable indicates that geographic access is a much more important issue for the poor. It is also the case that in the Bay Area these bridge-tunnel bottlenecks usually signify county boundaries. Since much of the public transit in the Bay Area is county-based, this finding may be capturing more than just a traffic bottleneck.

Although we did observe significant differences in hospital choice between high-risk and low-risk women, our estimates—due to our broad definition of high-risk—probably understate the true effect of risk on hospital choice. We expect that we would find a risk gradient if we refined our definition of high-risk into several groups of increasing risk. We chose not to do so in this analysis since our primary purpose was to see if there were differences in the choice decision across subgroups of patients, not to estimate precisely the magnitude of the effect of risk on hospital choice. Further, such an analysis would have been very difficult to undertake with the data we used, since ICD-9-CM codes indicate only the presence of a diagnosis, not its severity. In spite of these limitations, our results demonstrate that hospital choice is sensitive to patient risk and insurance status. Increased sensitivity to risk factors among high-risk women suggests that referral patterns are at least somewhat rational. The different results for Medi-Cal women reflect the segmented medical markets that influence choices for privately versus publicly insured women.

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NOTES

1. For more detail on how these zip codes were selected, see Garnick, Lichtenberg, Phibbs, et al. (1989).
2. For some hospitals, this data field includes some physician charges. The data indicate which hospitals also bill for physician services. We controlled for this in our regression model to calculate risk-adjusted charges.
3. The prediction errors of the original model are used as the dependent variable in a model where the independent variables are the weighted

average of each independent variable in the original model. The weights are the estimated probabilities from the original model.

4. This result is for the model comparing all high-risk deliveries with all low-risk deliveries. The statistic reported below for the nested logit model is also for this data set.
5. The Appendix available from the authors shows these guidelines and lists the ICD-9 codes that were used to classify women as high-risk.
6. Medicare was grouped with private insurance because it is a relatively "good" payer for delivery. Further, Medicare obstetrics patients are very rare, that is, only those women covered under the disability provisions of Medicare, and so forth.
7. We considered, and rejected, the possibility that cesarean section might be endogenous—that it is a function of some of the other independent variables and hospital choice. While a hospital's cesarean section rate may be influenced by the preferences of the women who deliver there, it is likely that most of the variance in cesarean section rates across hospitals is due to differences in the practice styles of the physicians on staff at each hospital. Because of this variation in practice styles, significant variability exists in the cesarean section rates across all of the other factors controlled for in the analysis.
8. Although there is a known volume-outcome relationship for births, we could not include any direct measures of number of hospital beds or patient volume in the model because these variables were highly collinear with several of the other variables in the model. Furthermore, we were attempting to explain choice of hospital based on variations in outcomes, not the reasons for variations in outcomes. In addition, the number of patients choosing a hospital from any one zip code is a small fraction of total volume.
9. For more details on the case-mix adjustments, see Garnick, Lichtenberg, Phibbs, et al. (1989) or Luft, Garnick, Mark, et al. (1990). Copies of these regression results are available from the authors on request.
10. Under selective contracting, Medicaid patients were restricted to receiving hospital care at contract hospitals, except on an emergency basis. By 1985, all of the areas in our study had been incorporated into the selective contracting program.
11. More than 12 years of education is used as a proxy for higher income. Educational level and income are very highly correlated, especially when aggregated to the zip code level.
12. A referee also noted that, since Medi-Cal patients do not pay any coinsurance, this result is consistent with economic theory.
13. A similar, but different explanation would attribute this difference to the fact that physicians who treat a larger number of Medi-Cal patients are less likely to let economics influence their medical decision making. Thus, they are not swayed to perform more cesarean sections by the higher reimbursement for operative deliveries. It may also be the case that some cesarean sections are encouraged by private physicians to end a long labor, while in hospitals using rotating physicians the responsibility for delivering the child is simply passed to the next-shift physician (Fraser et al. 1987).

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